

# RESEARCH NOTES

Rocky Mountain Forest and Range Experiment Station

Raymond Price, Director

FOREST SERVICE - U. S. DEPARTMENT OF AGRICULTURE

Headquarters at Fort Collins, Colorado,  
in cooperation with Colorado State University

May 1959

*return - @*

## MEASURING TRENDS OF BLACK HILLS BEETLE INFESTATIONS

by

Fred B. Knight, Entomologist

A sampling method for measuring trends in Black Hills beetle (Dendroctonus ponderosae Hopk.) infestations is needed for control planning. This note covers the progress on four phases of this important problem: (1) Sampling procedure for estimating beetle populations in the bole of the tree; (2) population in the lower bole of the trees compared to that in the upper bole; (3) results in terms of trend predictions; and (4) distribution of the samples and the negative binomial fit.

Trend is expressed in terms of the number of trees that become infested by the emerging beetle population. Three infestation classes are used: (1) Increasing - the emerging beetle population kill more trees than their parents; (2) static - they kill about the same number; and (3) decreasing - they kill fewer trees.

The sampling of beetle populations is complicated by the variability between samples at different levels within a tree and between trees. The procedure must be practical, yet it must give a valid estimate of the trend of the infestation. An estimate of the total number of beetles on any area or in any tree is not required. The study was based upon the assumption that the number of beetles surviving under a unit area of bark is directly related to the course of the infestation.

INFORMATION STATION  
Central Region, Fla.

34163

No. 37

BLACK HILLS BEETLE

### Determination of Number and Size of Samples

The efficiency of three sizes of bark area for the samples was compared. Population estimates with an error of less than 10 percent were obtained from survival counts in 60 samples, 3 by 6 inches; 50 samples, 6 by 6 inches; or 39 samples, 6 by 12 inches. Counts can be made on 50 samples 6 by 6 inches in size faster than on 39 samples 6 by 12 inches. The 6-by-6 is also better than the 3-by-6 samples because of the large number of zero counts in the latter. Thus, a sample 6 by 6 inches in size was chosen.

### Population in Lower Bole Compared to That in Upper Bole

A practical procedure required that the sample be taken from the lower bole to avoid felling the infested tree. Beal,<sup>1/</sup> Blackman,<sup>2/</sup> and Hopkins<sup>3/</sup> indicate that the population in the lower bole is comparable to that in the upper bole. DeLeon<sup>4/</sup> shows that at low population levels the greatest number of beetle entrance holes in large trees are found at 10 to 15 feet above the ground, but in increasing infestations the lower bole is equally infested. He found the distribution of entrance holes on selected large trees to be as follows:

	<u>Height in feet</u>				
	<u>5</u>	<u>15</u>	<u>25</u>	<u>35</u>	<u>45</u>
Entrance holes per square foot	6.6	6.0	6.0	5.3	5.3

---

<sup>1/</sup> Beal, J. A. The Black Hills beetle, a serious enemy of Rocky Mountain pines. U. S. Dept. Agr. Farmers' Bul. 1824, 20 pp., illus. 1939.

<sup>2/</sup> Blackman, M. W. The Black Hills beetle (Dendroctonus ponderosae Hopk.). N. Y. State Col. Forestry, Syracuse Univ., Tech. Pub. 36, 97 pp., illus. 1931.

<sup>3/</sup> Hopkins, A. D. The Black Hills beetle. U. S. Bur. Ent. Bul. 56, 24 pp., illus. 1905.

<sup>4/</sup> DeLeon, D. The biology and control of the Black Hills beetle (Dendroctonus ponderosae Hopk.). Summary of studies in Colorado and Wyoming 1935-1938. U. S. Bur. Ent. & Plant Quar., Div. Forest Insect Invest., Ft. Collins, Colo. 56 pp., illus. 1939. [Typewritten report.]

More recently and on smaller pines, mean d.b.h. 10 inches, the author obtained similar results as follows:

		<u>Height in feet</u>			
		2	5	10	20
Entrance holes					
per square foot:					
	1953	6.1	6.1	5.1	2.6
	1954	4.6	4.6	3.1	2.1

Progeny numbers are also fairly uniform throughout the bole, at least up to April (table 1). Survival by July is somewhat higher in the lower bole. Since the survival in July above 5 feet is lower than at 5 feet, it is concluded that samples of the brood at 4 to 7 feet above the ground can be used as indicators of population changes.

Table 1. --Brood density of Black Hills beetle at various heights above ground, as determined from 6- by 6-inch samples

Area	Date sampled	Height of sample			
		2 feet	5 feet	10 feet	20 feet
Number living beetles per square foot					
Area 1	April 1953	72.0 + 5.6	96.8 + 6.0	75.2 + 6.8	37.6 + 6.8
	July 1953	12.0 + 2.8	15.2 + 4.0	9.2 + 2.0	7.6 + 2.4
Area 2	April 1954	62.4 + 5.6	75.2 + 7.2	64.8 + 6.0	60.8 + 8.8
	July 1954	18.0 + 3.2	12.0 + 2.4	9.2 + 2.4	5.6 + 2.0
Area 3	July 1955	67.6 + 10.0	56.0 + 8.0	70.8 + 9.6	49.2 + 10.0
Area 4	July 1955	9.2 + 2.4	5.6 + 2.4	2.8 + 1.2	---

### Trend Predictions

The 25 infested trees to be sampled were selected from several of the infested groups within the study area, never from one large group. The brood was sampled as each infested tree in a group was found, without checking size or other factors that might be selective. The trees were selected and first sampled in the fall soon after the eggs had hatched. Two samples were taken from each tree, one from the north and the other from the south exposure. The same trees were again sampled in April and finally in July before the adult beetles left the trees.

After the beetles emerged and entered green trees, a systematic survey was made to determine the number of newly infested trees and the number infested a year earlier. The trend was determined by the

ratio of the number of newly infested trees to the number of trees infested the previous year.

The relation of Black Hills beetle populations in April (larvae) and July (adults) to the number of trees infested in August and September by trend-of-infestation classes is shown below:

DECREASING		STATIC		INCREASING	
<u>April</u>	<u>July</u>	<u>April</u>	<u>July</u>	<u>April</u>	<u>July</u>
- - - - - (Number beetles per square foot) - - - - -					
30	9	114	25	137	72
38	5	106	26	93°	36
64*	1	59*	27	89°	38
35	4	62*	23	129	64
36	6			159	74
89*	2				
90*	14				

Measurements in these 16 infestations showed no relationship between the population in the fall and the subsequent trend. The counts recorded in areas where increasing infestations were present had no more beetles per unit area of bark than in areas of decreasing infestation. Neither did the readings in April prove reliable for prediction purposes. Note that three of the averages\* in the decreasing category are greater than two of the averages\* in the static category. Also, that two of the averages° in the static category are greater than two of the averages° in the increasing category.

Counts made in July before the new generation of beetles emerged from the trees reflected infestation trend without exception. No overlapping of estimates were found in the 16 infestations measured in July. It is known, however, that a population can be greatly reduced during the flight period. This could conceivably result in a decreasing infestation in spite of a recorded high population count in July.

Unfortunately the period between the counts in July and the flight period is too short to permit control action. Additional studies are needed from April to July to determine the earliest date that sampling data will reflect the trend. Also, a technique is needed to study and determine the mortality during flight.



### Distribution of Samples

The distribution of the samples as measured in July are shown in figure 1. Note the high proportion of zero and 1 to 10 counts in the decreasing and static categories. This suggests that a "contagious" type of distribution might fit.

The negative binomial distribution was fitted to each of the three infestation classes. The procedure used for computing the negative binomial and for testing its fit is described by Bliss and Fisher.<sup>5/</sup> The negative binomial showed a good fit for both the decreasing and static infestations. For increasing infestations a good fit was obtained except for a discrepant value for the number of samples with zero count.

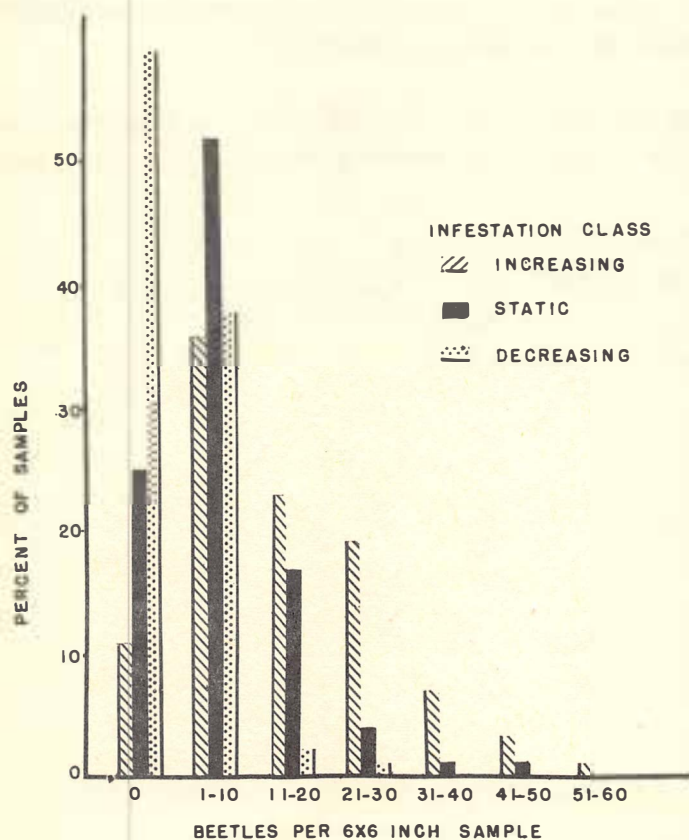


Figure 1. --Distribution of samples taken in July.

---

<sup>5/</sup> Bliss, C. I., and Fisher, R. A. Fitting the negative binomial distribution to biological data and note on the efficient fitting of the negative binomial. Biometrics 9: 176-200. 1953.

## Summary

Results of investigation of sampling methods for measuring populations of the Black Hills beetle and trends in infestations are as follows:

1. Counting the insects in 50 samples (2 from each of 25 trees) 6 by 6 inches in size gives a reliable estimate of beetle numbers per square foot.
2. These samples may be taken from the lower bole, 4 to 7 feet above ground. Population fluctuations at that point were similar to those in the upper bole.
3. Populations in the infested trees in the fall and April were unrelated to infestation trend in the 16 study areas. Populations on the same trees in July before the beetles emerged were directly related to the infestation trend.
4. The distribution of samples can be fitted to the negative binomial. This will be of value in the development of a sequential sampling system.

*The problem is - a sequential sampling system for one factor (e.g. D. ponderosae) will not suffice for all factors (and obtainable from some bore samples) such as for mite, forest, etc. That is - no single sampling method or scheme will suffice for all.*